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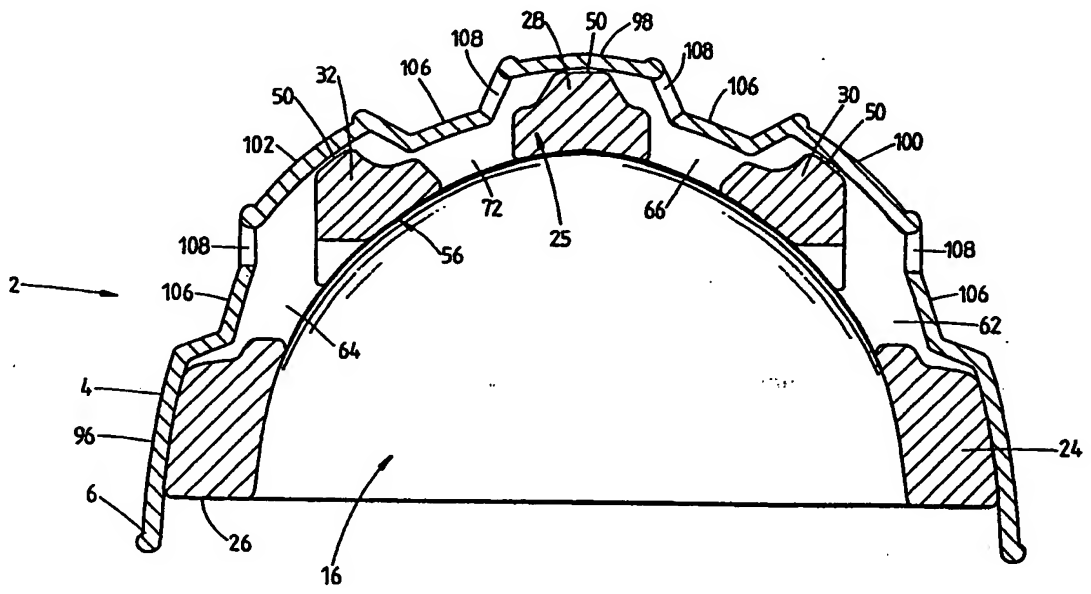

(57) Abstract

A liner (16) for a helmet (2) the liner having a non-uniform or contoured outer surface which provides relatively small areas (50) of contact with the inner surface of the outer protective shell (4). This enables more effective cushioning to be obtained from deformation of the liner when the helmet is subjected to moderate impacts. Also novel ventilating arrangements are disclosed. The liner can be used in a conventional helmet which has a relatively thick shell, a microshell arrangement which has a very thin outer shell or a shell-less arrangement in which there is no protective layer or a fabric outer layer.

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SAFETY HELMET AND LINER THEREFOR

This invention relates to a safety helmet and liner therefor.

It is known to make a safety helmet suitable for cycling and other sports by moulding an outer plastic shell and providing an inner liner of expanded polystyrene, polyurethane, polyethylene or other shock absorbing material. Normally the liner is of generally uniform thickness and fits snugly inside the shell. It is also known to provide holes in the shell which communicate with correspondingly located openings in the liner. The aligned holes permit flow of air into the liner for ventilation so as to make the wearing of the helmet more comfortable.

The present invention provides a novel form of liner which has a number of advantages.

According to the present invention there is provided a liner for a safety helmet, said liner having an outer surface formed with projections which, in use, engage the inner surface of a shell of the helmet.

The projections effectively reduce the surface area of the lining which is in contact with the inner surface of the shell. Upon impact, the projections will be subjected to greater stress would be the case if the liner had a uniform outer surface. This results in localised deformation of the projections at relatively lower stresses. This has the advantage that when the helmet is subjected to a low or moderate impact, the liner offers a relatively low resistance thereby reducing magnitude of forces transmitted to the head of the user and thus reduces the possibility of an injury. When there is a larger impact, there will initially be the cushioning effect of the projections but once they have deformed, the main body of the liner will come into play and provide substantial resistance and so protect the user under these conditions as well.

Preferably, the projections increase in width (as seen in cross-section) away from their free ends. This enhances the effect of progressive resistance to applied stresses.

Preferably further, the profile of the projections is curved (as seen in cross-section). It is further preferred that at least part of the profile comprises a hyperbolic curve.

Preferably further, the projections comprise ribs. Preferably further, there are generally longitudinally extending ribs and at least one transversely extending rib.

Preferably further, openings are provided in the liner between the interstices of the ribs.

The invention also provides a safety helmet comprising an outer protective shell and a liner as defined above located within the shell.

Preferably, the shell has openings therein which permit a flow of air into the spaces between adjacent projections of the liner. It is also preferred that at least some of the openings in the shell correspond generally in position with openings in the liner in order to permit flow of air to the interior of the liner.

Preferably the shell is injection moulded from PBT polyester and has a thickness in the range 2mm to 3mm.

The invention also provides a liner for a safety helmet, said liner comprising:

a body having a concave recess in which, in use, the head of the wearer is located, and

an outer surface which is non-uniform and has a plurality of outer regions which lie on an imaginary surface which is generally uniformly spaced from the concave recess.

The invention also provides a liner for a safety helmet said liner comprising:

a body having a crown portion, rim portion and concave recess in which, in use, the head of the wearer is located,

the crown portion having an outer surface which is contoured and which has a plurality of outer regions which lie on an imaginary surface which corresponds in shape to the adjacent parts of the concave recess and a plurality of inner surface portions which lie between the concave recess and said imaginary surface, the ratio of the sum of the surface areas of said outer regions relative to sum of the surface areas of said inner surface portions being substantially less than unity.

The invention also provides a safety helmet comprising a liner and an outer shell, the liner including at least one groove extending from near the front of the liner to the rear, said at least one groove and the inner surface of the shell forming at least one air passage, said outer shell including at least one opening near the front thereof and at least one opening near the rear thereof, said openings communicating with said at least one air passage, whereby in use a stream or streams of air enter and flow along said at least one air passage, said line further including openings which communicate the interior of the liner with said at least one air passage whereby in use air from within the liner is drawn through said openings into said stream or streams of air to thereby ventilate the interior of the liner.

It is also possible to utilise the principles of the invention to make a so–called microshell helmet. Helmets of this construction can use the liner defined above with an outer protective shell which overlies the liner. The outer protective layer shell can be moulded or formed from relatively thin plastics material such as polypropylene, PBT or ABS of a thickness in the range 0.5 to 1.0mm. The protective layer can be moulded by using vacuum moulding techniques. It is also possible to use a fabric cover instead of the moulded protective shell. Means is provided for connecting the straps of the helmet to the shell. One convenient arrangement is to provide slots in the shell through which the strap can be threaded to enable the strap to pass from one side of the shell to the other and so form the interconnection with the shell.

Accordingly the invention provides a microshell safety helmet said helmet comprising a body having a concave recess in which, in use, the head of the wearer is located, an outer surface of the body being non-uniform and having a plurality of outer regions which lie on an imaginary surface which is generally uniformly spaced from the concave recess, a relatively thin outer shell which overlies the outer surface and straps which are coupled to the body.

The invention also provides a microshell helmet, said helmet comprising a body having a crown portion, rim portion and concave recess in which, in use, the head of the wearer is located, the crown portion having an outer surface which is contoured and which has a plurality of outer regions which lie on an imaginary surface which corresponds in shape to the adjacent parts of the concave recess and a plurality of inner surface portions which lie between the concave recess and said imaginary surface, the ratio of the sum of the surface areas of said outer regions relative to the sum of the surface areas of said inner portions being substantially less than the unity, and a relatively thin outer shell covering at least the crown portion and strap means coupled to the body.

The invention will now be further described with reference to the accompanying drawings, in which:

FIGURE 1 is a side view of a safety helmet constructed in accordance with the invention;

FIGURE 2 is a schematic plan view of a liner for the helmet;

FIGURE 3 is a schematic cross-sectional view taken along the line 3-3 of Figure 2 and showing the shell;

FIGURE 4 is a schematic section along the line 4-4;

FIGURE 5 is a schematic section along the line 5-5;

FIGURE 6 is a sectional view through a preferred profile of rib;

FIGURE 7 is a sectional view through another rib profile with the adjacent

shell;

FIGURES 8 and 9 diagrammatically illustrate effective changes in the stress–strain relationship in liners of the invention;

FIGURE 10 shows a shell–less helmet utilising the liner of Figures 2 to 5;

FIGURE 11 is a perspective view of a shell–less helmet constructed in accordance with the invention;

FIGURE 12 is a perspective view of the outer protective layer of the helmet of Figure 11;

FIGURE 13 is a perspective view of the main supporting body of the helmet of Figure 11;

FIGURE 14 is a schematic cross–sectional view of the shell–less helmet of Figure 12; and

FIGURE 15 illustrates air flows in the helmet of Figure 12.

Figure 1 illustrates a safety helmet 2 constructed in accordance with the invention. It comprises an outer shell 4 which is preferably moulded or formed from plastic material such as PBT polyester. The bottom rim 6 of the shell is formed with a bead and is shaped to sweep downwardly from the front 8 of the helmet to a temple protecting region 10 and then upwardly to define an ear cut out 12 and then continues to the rear 14 of the helmet. Located within the shell is a liner 16 of the invention. The liner 16 is fully located within the shell and is thus not visible in Figure 1. The helmet includes a pair of forward straps 18 one end of each of which is riveted to respective sides of the helmet. The helmet includes rear straps 20 one end of each of which is riveted near the rear of the helmet. The straps 18 and 20 co–operate with buckles 22 and a fastening member (not shown) for firmly holding the helmet on the wearer's head.

Figure 2 shows a top view of the preferred form of liner 16 of the invention. It is preferably moulded from expanded plastics material such as polystyrene material having a density in the range of 40 to 100 grams per litre and preferably 75 grams per litre. The liner has a lower rim portion 24 which extends fully about the lower part

of the liner and a crown portion 25. The rim portion 24 is of approximately uniform thickness and its lower edge 26 is shaped so as to be similar in shape to the rim 6 of the shell, as best seen in Figure 3. The rim 6 of the shell extends lower than the edge 26 of the liner so that the liner is not normally visible from the sides of the helmet.

Normally a liner is a hemi-ovoid shell having a cavity 25, the wall thickness of the shell is generally uniform in thickness, say about 20mm, although there may be some holes for ventilating the interior of the liner. In the liner of the invention, the outer surface of the crown 25 is substantially non-uniform. In the illustrated arrangement, the crown 25 is provided with a central longitudinally extending rib 28 and intermediate longitudinally extending ribs 30 and 32. The ribs 28, 30 and 32 extend from the front 40 of the liner to the rear 42 of the liner. The crown includes a transverse rib 44 which extends transversely across the liner and is located somewhat towards the rear of the crown. The outer surfaces 50 of the ribs are arranged to contact or lie closely adjacent to the inner surface of the shell 4 of the helmet. The liner 16 may be retained in the helmet by the resilient action of the shell 4 which holds it captive therein and/or by adhesives.

It will be appreciated that the liner of the invention can be alternatively regarded as a hemi-ovoid shell with a non-uniform or contoured outer surface, the outer surfaces having recesses or depressions between which are defined the tapering parts referred to as the ribs above.

The outer surfaces 50 of the ribs 28, 30 and 32 taper from the centre of the crown towards both the forward and rear parts of the helmet 40 and 42. This is illustrated in Figures 4 and 5 which show the change in profile of the rib 28 from the forward part of the rib 40 up towards the transverse rib 44. On the other hand, the rib 44 tends to widen from the crown towards the rim 24.

The provision of the ribs substantially influences the behaviour of the liner when subjected to mechanical loads. This is illustrated diagrammatically in Figures

8 and 9. Considering first Figure 8, there is shown a cubic or cuboidal block 46 of expanded polystyrene similar to that normally used in conventional liners which take the form of a shell of more or less uniform thickness. When a load is applied to the block 46 the block will deform in a non-linear manner as is apparent from the graph which shows the stress-strain relationship for blocks of densities of 20, 40, 60 and 80 grams per litre. It is firstly noted that the response is significantly affected by the density of the material. It will also be noted that the non-linear behaviour is quite pronounced at lower strains and in particular the responses have higher gradients at this point. The practical effect of this is that for low or moderate impacts applied to the helmet, relatively low strain occurs in the liner and consequently quite significant forces are transmitted to the head of the user. It would be preferable for the material to exhibit a lower gradient at this region so that the liner could provide more cushioning when the helmet is subjected to low or moderate impacts.

Figure 9 illustrates the corresponding responses of a block 46 which has a curved profile. It will be appreciated that at the apex of the block 46, strain will occur at lower levels of load but as the strain increases, the resistance of the block also increases. This is reflected in the stress-strain curve. First it will be noticed from the graph that the response curves are less dependent upon the densities of the materials. It will be further noted that the response curves are more linear particularly at lower levels of strain. Thus the curved block 46 is able to provide better cushioning for low or moderate impacts yet still provides protection when higher stresses are applied. This therefore enables the possibility of utilising foamed materials over a greater range of densities. Lightweight liners could be made by using higher density material. More importantly, higher density materials can be used because the overall volume of material is lower compared with convention liners of generally uniform thickness. The use of higher density material enables the liner to withstand higher impacts without adversely affecting its performance at low or moderate impacts.

A preferred profile of the ribs is illustrated in Figure 6. In this arrangement,

the outer surface 50 of the rib has flats which would engage or lie adjacent to the inner surface of the shell. From the outer surface 50 to hyperbolic surfaces 52 and 54 which extend for approximately half the thickness of the liner, the remaining surface parts being flat inclined regions 58 and 60. In this profile, the outer parts defined by the hyperbolic surfaces provide the programed shock absorption which is restricted to about 50% of the available thickness of the liner. The flat regions 58 and 60 of the rib profile provides the additional strength required to withstand higher stresses.

It is preferred that the total area of the outer surfaces of the ribs, that is to say those parts of the ribs which contact the inner side of the shell 4, such as the top surfaces 50 comprise a relatively small percentage of the overall area of the outer surface of the shell. Because the crown 25 is substantially non-uniform this can more easily be expressed in relation to the surface area of the concave inner surface 56 of the liner. It is preferred that the ratio of the total area of the surfaces 50 to the surface area of the concave inner surface of the liner is in the range from say .05 to .35 and preferably .2. This requirement can also be expressed in relation to the ratio of the sum of the surface areas of the surfaces 50 and the sum of the remaining outer surface portions of the liner which lie between the surfaces 50 and the concave surface 56. Again this ratio is in the range from .05 to .35 and preferably .2. The imporatan consideration of course is that at least in the crown 25 there is a relatively small surface area which engages the inner surface of the shell 4.

Figure 7 shows another preferred rib profile. In this arrangement, the rib 61 has flat inclined surfaces 63 and 65 and a central relatively deep groove 67 the cross-sectional profile of which is preferably a hyperbolic curve. The arrangement of Figure 7 provides an enhanced degree of programed deformation under impact loads. Figure 7 also illustrates the profile of the shell 4. It will be seen that it follows the outer profile of the liner except that it spans the groove 67. In a modified arrangement, it would be possible to arrange for a relatively small gap (not shown) to be left between the trough portions 67 of the shell and the base level 69 of the liner. This

arrangement would of course give very good cushioning at relatively low impact because the outer parts of the rib would crush under relatively low loads before the trough portion 67 come into engagement with the base level surface parts 69.

It will be appreciated from the above that the profile of the ribs of the liner of the invention gives a stress-strain response which is like the response of Figure 9 rather than the non-linear response of Figure 8. Thus a helmet of the invention provides better cushioning at low or moderate impacts and provide for a gradual shock absorbtion.

The profile of the ribs of the liner of the invention also enables the use of more dense expanded plastics materials such as polystyrene which extends the protective range of the helmet, it being appreciated that initial crushing of the outer parts of the ribs will occur at relatively low stresses.

Referring again to Figure 2, it will be seen that the liner includes a number of openings between the ribs. In particular, the forward part of the helmet includes outer openings 62 and 64 between the ring 24 and the ribs 30 and 32. The forward part also has three openings 66, 68 and 70 between the ribs 28 and 30, there being symmetrically disposed openings 72, 74 and 76 between the ribs 28 and 32. The rear part of the liner has a similar arrangement with openings 78 and 80 disposed respectively between the ring 24 and the ribs 30 and 32. The rear part also includes three openings 82, 84 and 86 between the ribs 28 and 30 and symmetrically disposed openings 88, 90 and 92 between the ribs 28 and 32. The openings in the forward part of the liner are designed to permit air to pass into the interior of the liner for ventilation and at least some of the openings in the rear part of the liner are used for escape of air.

The preferred shape of the outer shell 4 is illustrated in Figures 1 and 3. It will be seen that the shell includes a lower rim portion 96 which extends about the lower rim of the shell. The shell is moulded with three longitudinally extending

flattopped ribs 98, 100 and 102 which overlie the ribs 28, 30 and 32 respectively. The shell also includes a transverse rib 104 which overlies the transvers rib 44 of the liner. The shell includes intermediate surface portions indicated generally by the reference numeral 106 which extend between the ribs 98, 100 and 102 and between the ribs 100, 102 and the lower rim 96. Generally speaking, the intermediate portions 106 are located at lower levels than the adjacent parts of the shell. This provides an attractive appearance for the shell but more importantly enables provision of ventilating holes 108 in the shell at relatively depressed levels compared to the outer surface regions of the shell. The openings permit air to pass into the spaces between adjacent ribs and thus provide ventilation of this between the liner and the shell. Also some of the air will pass through the openings in the liner itself and thus permit ventilating air to enter the interior of the liner.

Figure 10 schematically illustrates a cross-section through a shell-less helmet 120 constructed in accordance with the invention. The helmet comprises a liner 16 which is of similar construction to that of the liner described previously and need not therefore be further described (the same reference numerals are used where relevant). The helmet includes a front strap 124 which is coupled to the liner by threading it through the opening 62 across the ribs 30, 28 and 32 and then down through the opening 64. The strap may include a fastening buckle (not shown). A rear strap may be affixed in a similar way by threading it through the openings 78 and 80. Alternatively, separate openings may be provided in the shell in order to accommodate the straps.

The helmet 120 is completed by using a fabric outer covering (not shown) in Figure 10 for the liner 16. The function of the covering is mainly for appearance. It can comprise a fabric with an elasticised opening which is fitted over the liner 16.

Figures 11 to 14 illustrate a modified form of helmet 140 which is known as a microshell helmet. It has a liner 142 which is similar in many respects to the liner 16 and accordingly the same reference numerals are shown in these drawings to

denote corresponding parts. It does, however, have a very thin outer protective shell 144 which overlies the crown 25 and upper part of the rim 24 of the liner. As best seen in Figure 13, the liner 142 has lower parts 146 of the rim which are somewhat deeper at the forward and rear parts of the liner compared to that illustrated in Figures 2 and 3. The crown 25 includes the longitudinal ribs 28, 30 and 32 as well as the transverse rib 44. The ribs 28, 30 and 32 are formed with grooves 67 like in the arrangement illustrated in cross-section in Figure 7. In the front part of the crown, the openings 66 and 68 are merged into a single opening 152 and the openings 72 and 74 are merged into a single opening 150. At the rear part of the crown, the openings 90 and 92 are merged into a single opening 154 and the openings 66 and 68 are replaced by a single opening 156. The transverse rib 44 includes recessed portions 158 and 160 on either side of the central longitudinal rib 28. The front and rear parts of the crown include pairs of openings 162 through which a strap 124 can be threaded. The grooves 67 include a number of openings 164 which extend through to the inner surface 56 of the liner, as shown in Figure 14. These openings increase ventilation of the interior of the helmet as will be further described hereinafter. The shell 144 is illustrated in Figure 12. It has a shape which is generally complementary to the liner 146. It is preferably moulded from thin plastics material such as polypropylene, PBT or ABS having a thickness in the range from 0.5 to 1.0mm. It has eight openings which correspond in position to the openings 62, 64, 78, 80, 150, 152, 154 and 156 of the liner. It has longitudinally extending ribs 166, 168 and 170 which overlie the longitudinal ribs 28, 30 and 32 of the liner. The ribs 166, 168 and 170 do not follow the grooves 67 and therefore create longitudinally extending passages which run from the front to rear of the crown.

The shell 144 includes openings 172 in the ribs 166, 168 and 170 near the rear thereof and openings 173 near the front thereof. Similar openings are also formed in the ribs at the front of the cover. In use of the helmet a stream of air can enter the openings 173 at the front of the cover and travel into the longitudinal passages formed by the grooves 67 as indicated by arrows 175 in Figure 15 and exit via the openings 173 at the rear of the helmet. Secondary air streams 177 from the interior of the

helmet are drawn by venturi effect through the holes 164 to join the stream 175. This provides additional ventilation for the helmet in addition to that provided by the other openings of the helmet which have been described previously.

Many modifications will be apparent to those skilled in the art without departing from the spirit and scope of the invention.

CLAIMS:

1. A liner (16) for a safety helmet (2), said liner having an outer surface formed with projections (28,30,32) which, in use, engage the inner surface of a shell (4) of the helmet.

2. A liner as claimed in claim 1 wherein the liner (16) has the general shape of a hemi-ovoid shell having recesses (62,64,66,68,74,78,80,84,86,90,92) therein to define said projections therebetween.

3. A liner as claimed in claim 2 wherein the projections include longitudinally extending ribs (28,30,32).

4. A liner as claimed in claim 3 wherein the ribs decrease in width in directions away from the interior of the liner.

5. A liner as claimed in claim 3 or 4 wherein the ribs include grooves (67) on their outer surfaces.

6. A liner as claimed in claim 5 wherein the grooves (67) are defined in cross-section by a hyperbolic curve.

7. A liner as claimed in claim 3, 4, 5 or 6 wherein the ribs have sidewalls which are defined by curved surfaces in cross-section.

8. A liner as claimed in claim 3 wherein the rib is shaped so that it enhibits a generally linear stress-strain relationship when subjected to compression.

9. A liner as claimed in any preceding claim, said liner being integrally moulded from expanded polystyrene material having a density in the range 48 to 100 grams per litre.

10. A liner as claimed in claim 9 wherein the density is 75 grams per litre.

11. A liner as claimed in any preceding claim wherein the area of the outer surfaces of the projections which, in use, contact the inner surface of the shell (4) comprise about 20% of the total inner surface area of the liner.

12. A safety helmet (2) comprising an outer protective shell (4) having a liner (16) as defined in any preceding claim mounted therein.

13. A shell-less helmet (120,140) comprising a liner (16,142) as claimed in any preceding claim and strap means (124) for mounting the helmet on the head of a wearer.

14. A liner (16) for a safety helmet, said liner comprising:

a body having a concave recess (56) in which, in use, the head of the wearer is located, and

an outer surface which is non-uniform and has a plurality of outer regions (50) which lie on an imaginary surface which is generally uniformly spaced from the concave recess and has a plurality of other regions (52,54,63,65,67) which lie between said surface and said recess, said other regions including inclined or curved parts which diverge away from said outer regions (50) towards said recess (56).

15. A liner as claimed in claim 14 wherein said body has the shape of a hemi-ovoid shell.

16. A liner as claimed in claim 14 or 15 wherein the total surface area of said outer regions (50) is about 20% of the surface area of the recess (56).

17. A liner (16) for a safety helmet (2) said liner comprising:

a body having a crown portion, rim portion and concave recess in which, in use, the head of the wearer is located,

the crown portion having an outer surface which is contoured and which has a plurality of outer regions which lie on an imaginary surface which corresponds in shape to the adjacent parts of the concave recess and a plurality of inner surface portions which lie between the concave recess and said imaginary surface, the ratio of the sum of the surface areas of said outer regions relative to sum of the surface areas of said inner surface portions being substantially less than unity.

18. A safety helmet (140) comprising a liner (142) and an outer covering (144), the liner including at least one groove (67) extending from near the front of the liner to the rear, said at least one groove and the inner surface of the covering forming at least one air passage, said outer covering (144) including at least one opening (172) near the front thereof and at least one opening (172) near the rear thereof, said openings communicating with said at least one air passage, whereby in use a stream or streams of air (175) enter and flow along said at least one air passage, said liner further including openings (177) which communicate the interior of the liner with said at least one air passage whereby in use air from within the liner is drawn through said openings (177) into said stream or streams of air (175) to thereby ventilate the interior (56) of the liner.

19. A helmet as claimed in claim 18 wherein the covering (144) comprises a moulded shell.

20. A helmet as claimed in claim 19 wherein the wall thickness of the shell is in the range 0.5mm to 1.0mm.

21. A microshell safety helmet (120) said helmet comprising a body (16) having a concave recess (56) in which, in use, the head of the wearer is located, an outer surface of the body being non-uniform and having a plurality of outer regions (50) which lie on an imaginary surface which is generally uniformly spaced from the concave recess (56), a relatively thin outer shell (144) which overlies the outer surface and straps (124) which are coupled to the body.

22. A microshell helmet, said helmet comprising a body having a crown portion (25), rim portion (124) and concave recess (56) in which, in use, the head of the wearer is located, the crown portion (25) having an outer surface which is contoured and which has a plurality of outer regions (50) which lie on an imaginary surface which corresponds in shape to the adjacent parts of the concave recess (56) and a plurality of inner surface portions (52,54,58,60,63,65,67) which lie between the concave recess and said imaginary surface, the ratio of the sum of the surface areas of said outer regions relative to the sum of the surface areas of said inner portions being substantially less than the unity, and a relatively thin outer shell (144) covering at least the crown portion and strap means (124) coupled to the body.

FIG 1

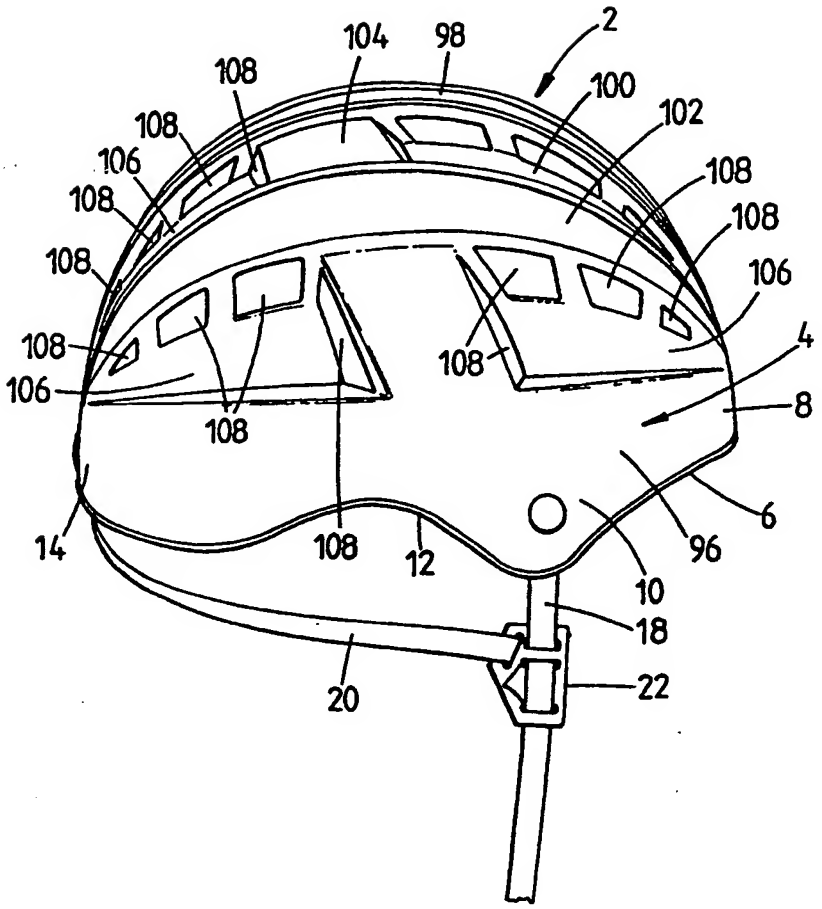
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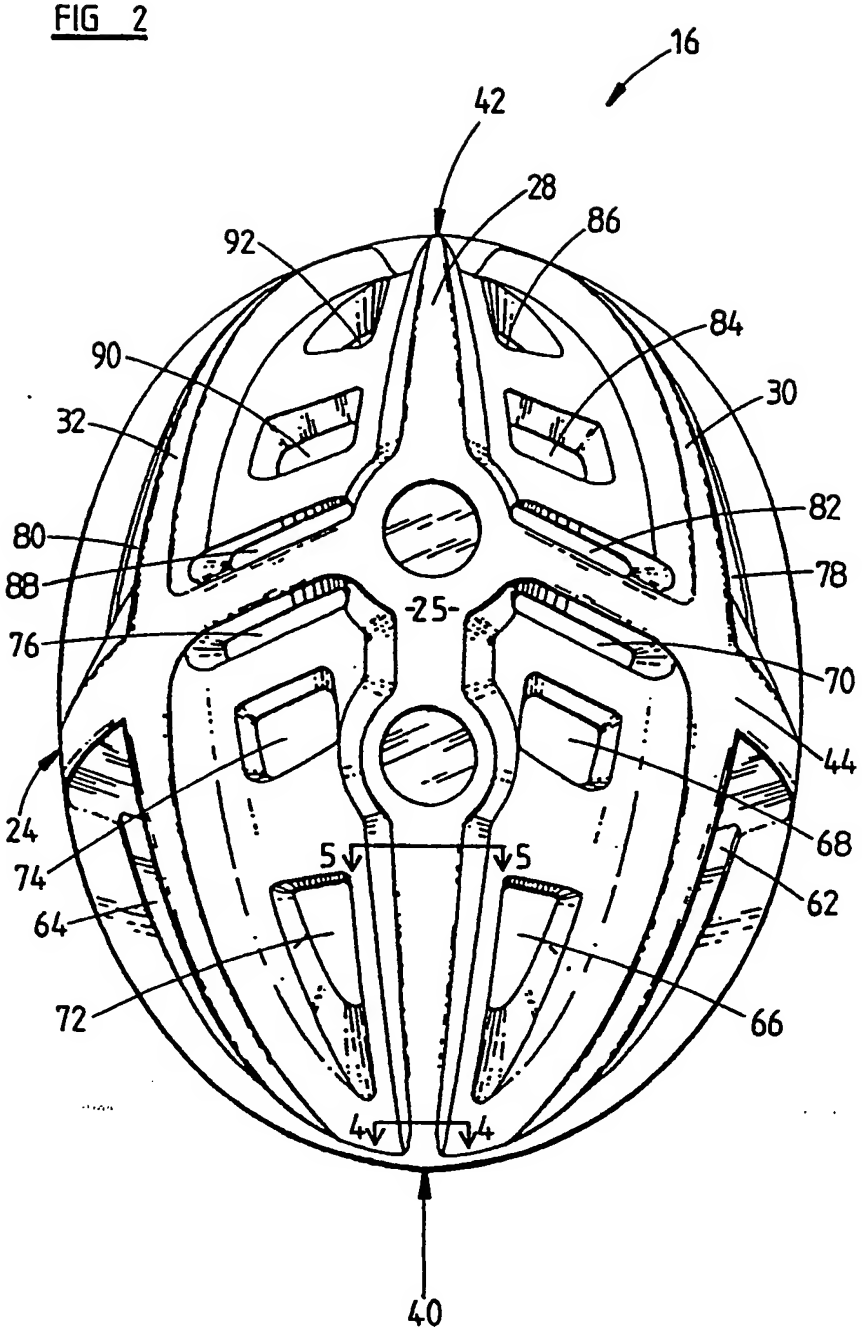
FIG 2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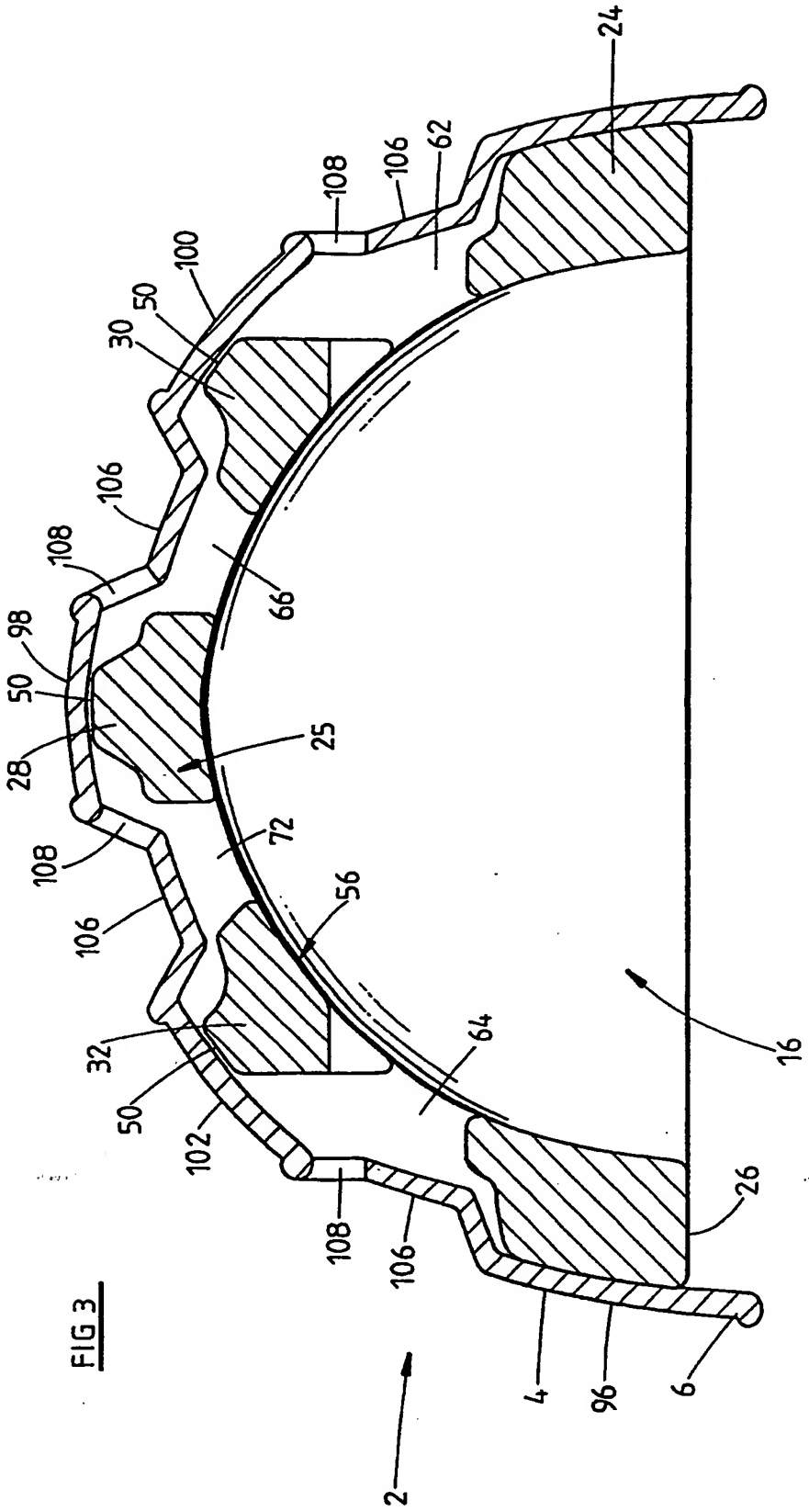
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FIG 3

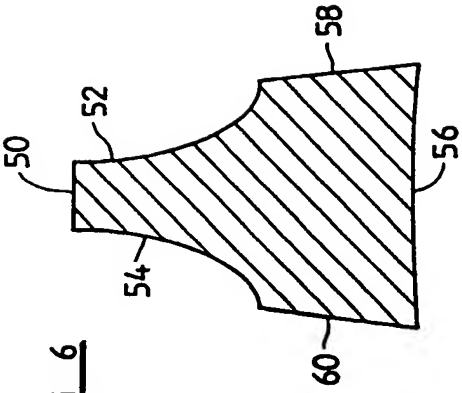


FIG 6

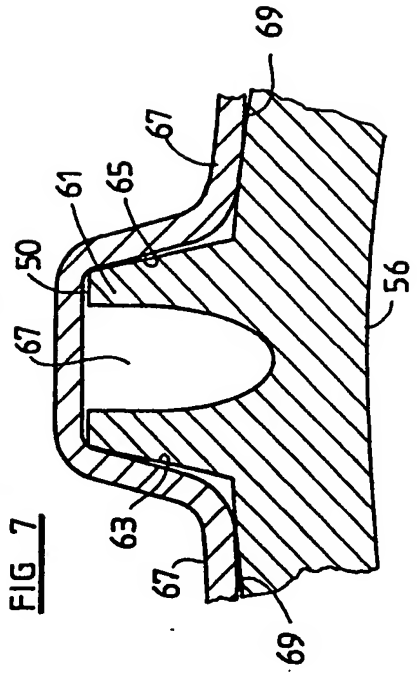


FIG 7

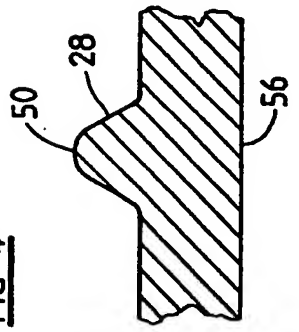


FIG 4

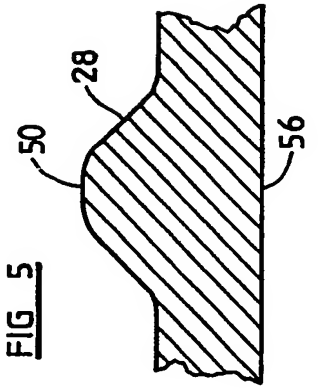


FIG 5

FIG 8

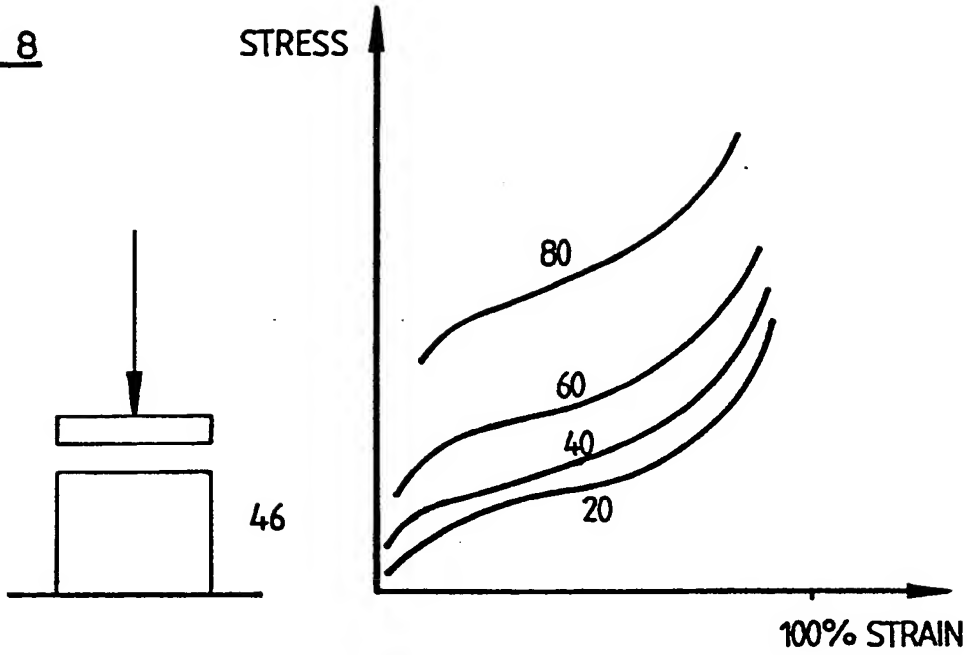
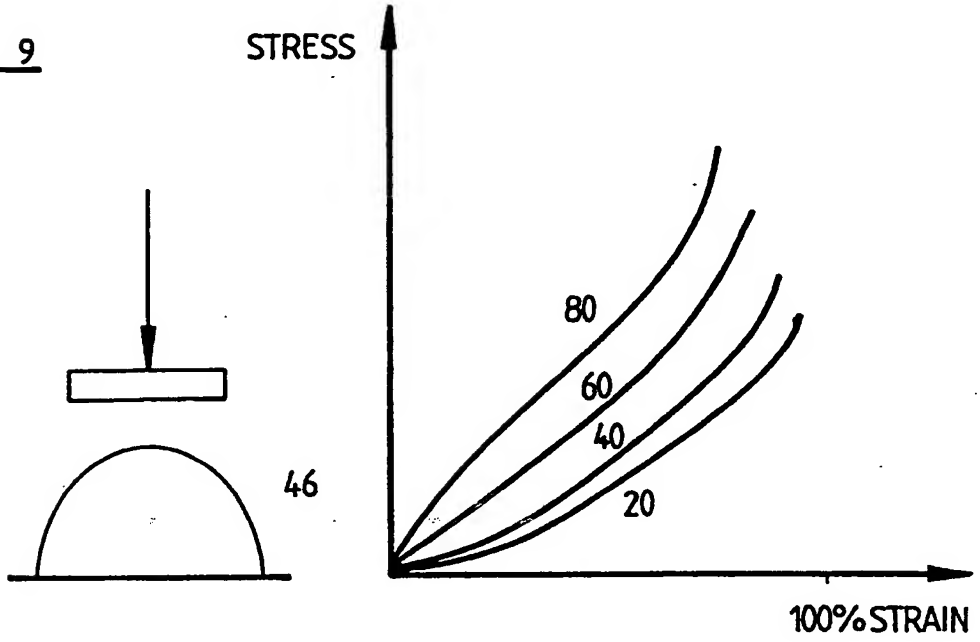

STRESS
80
60
40
20
46
100% STRAIN

FIG 9


STRESS
80
60
40
20
46
100% STRAIN

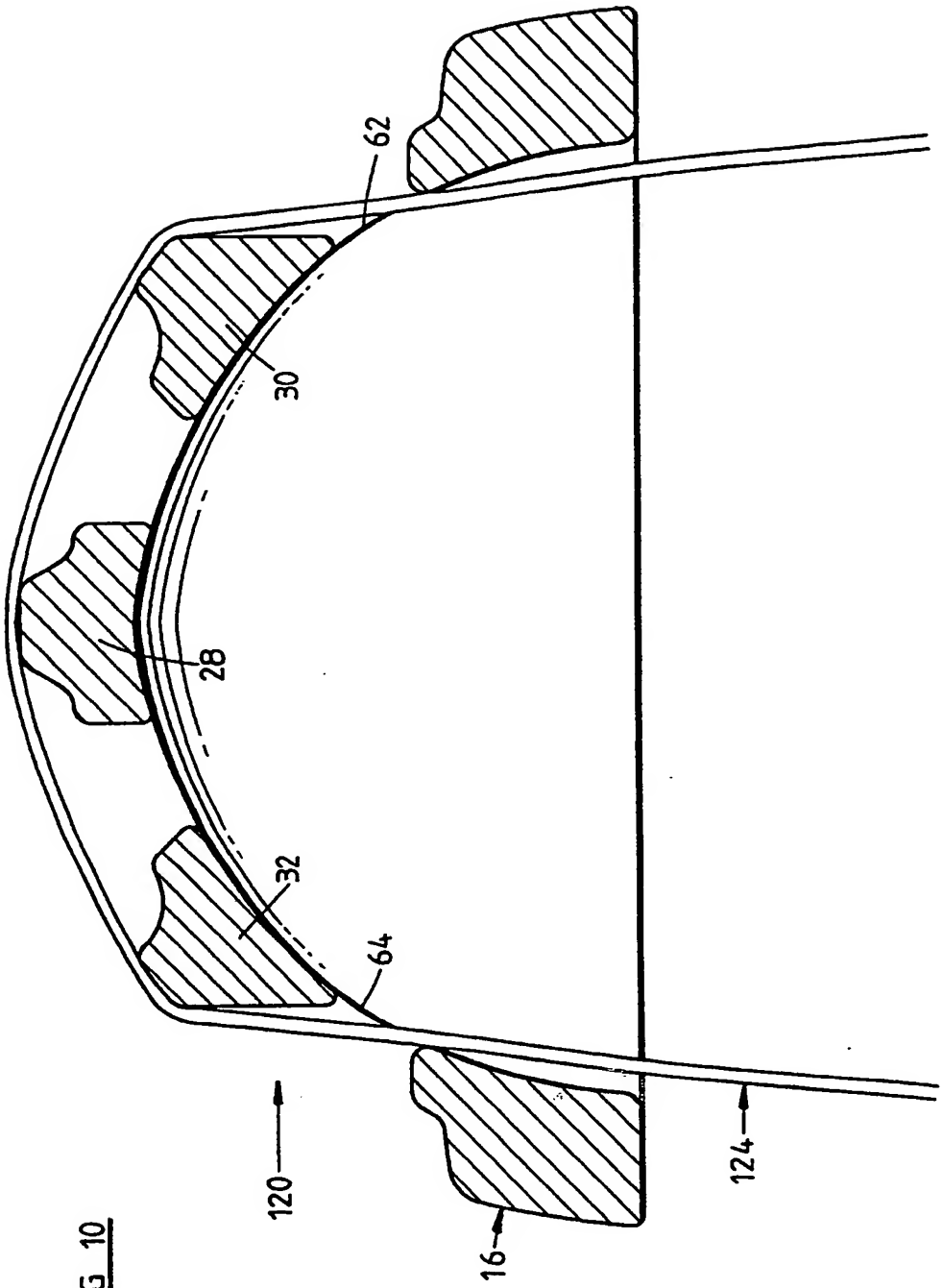


FIG 10

FIG 11

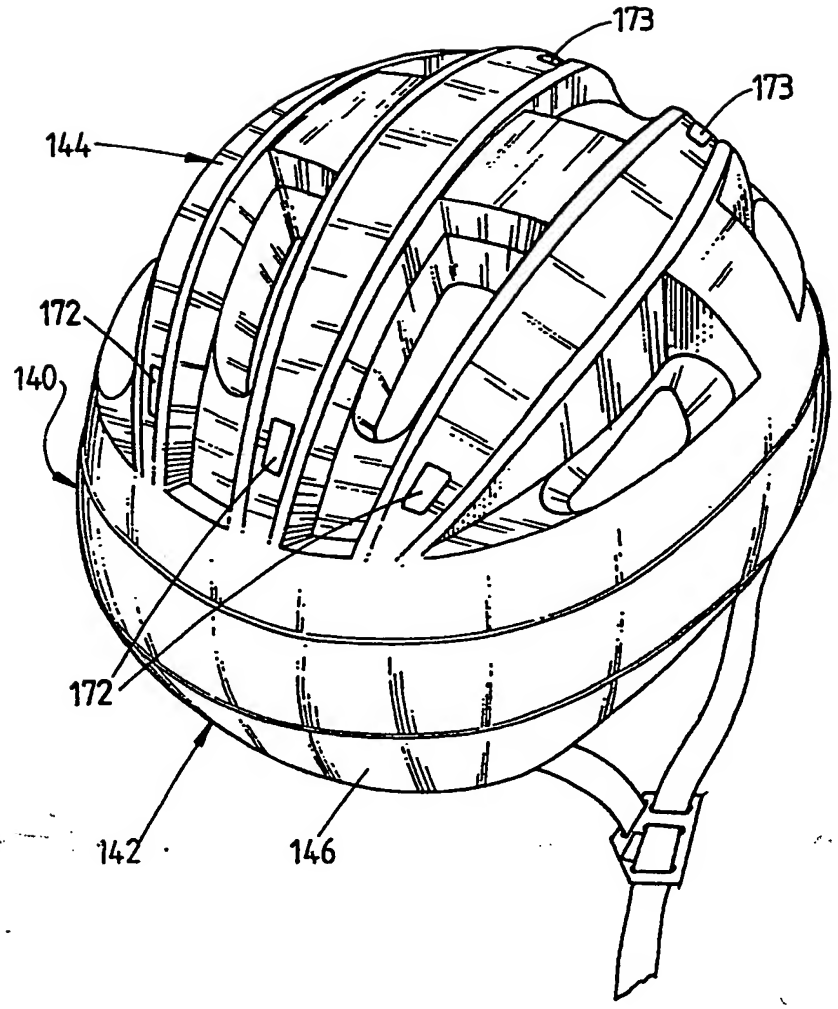


FIG 12

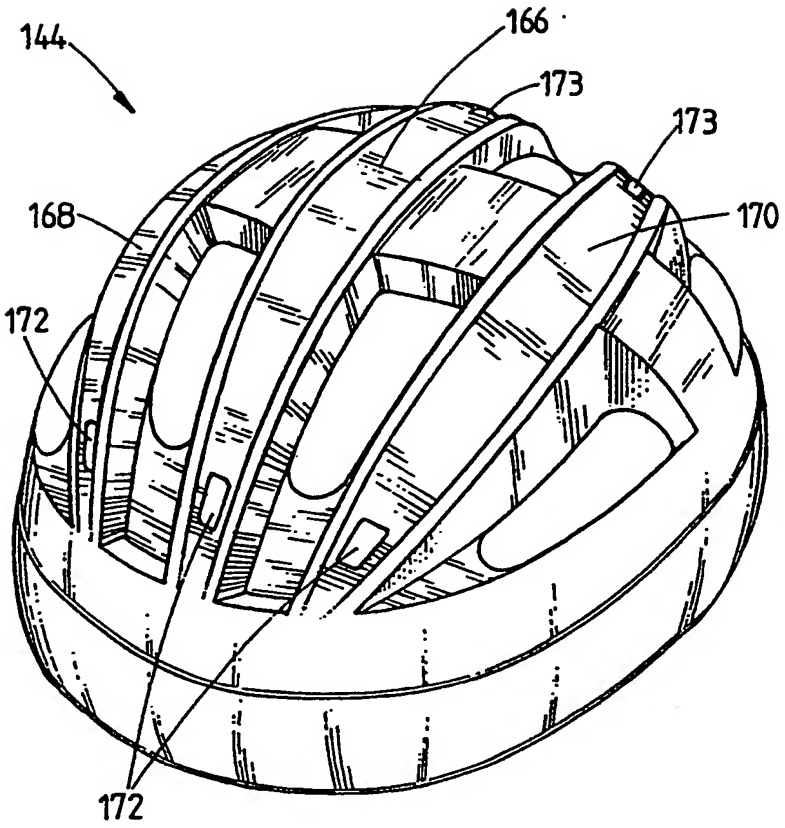


FIG 13

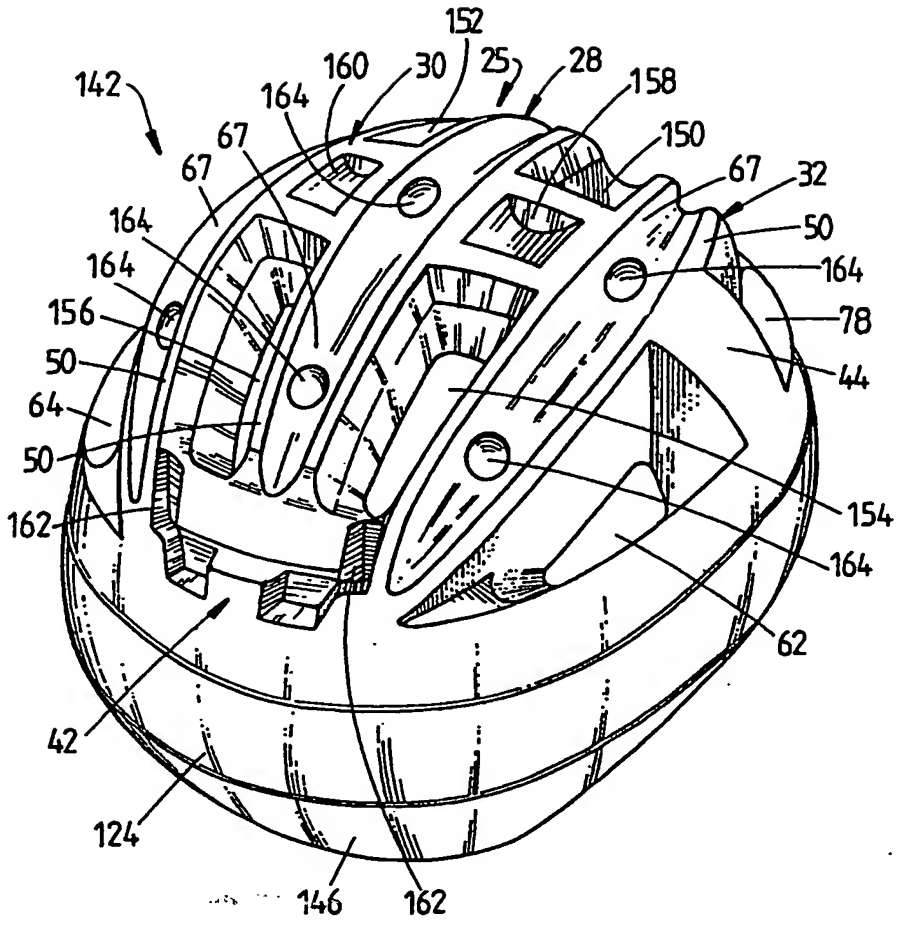

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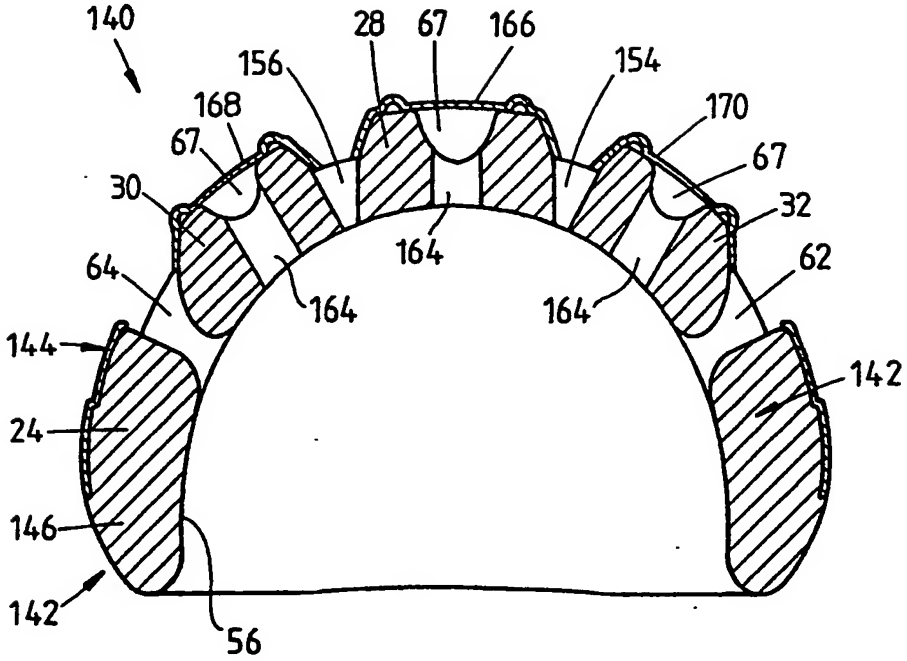
FIG 14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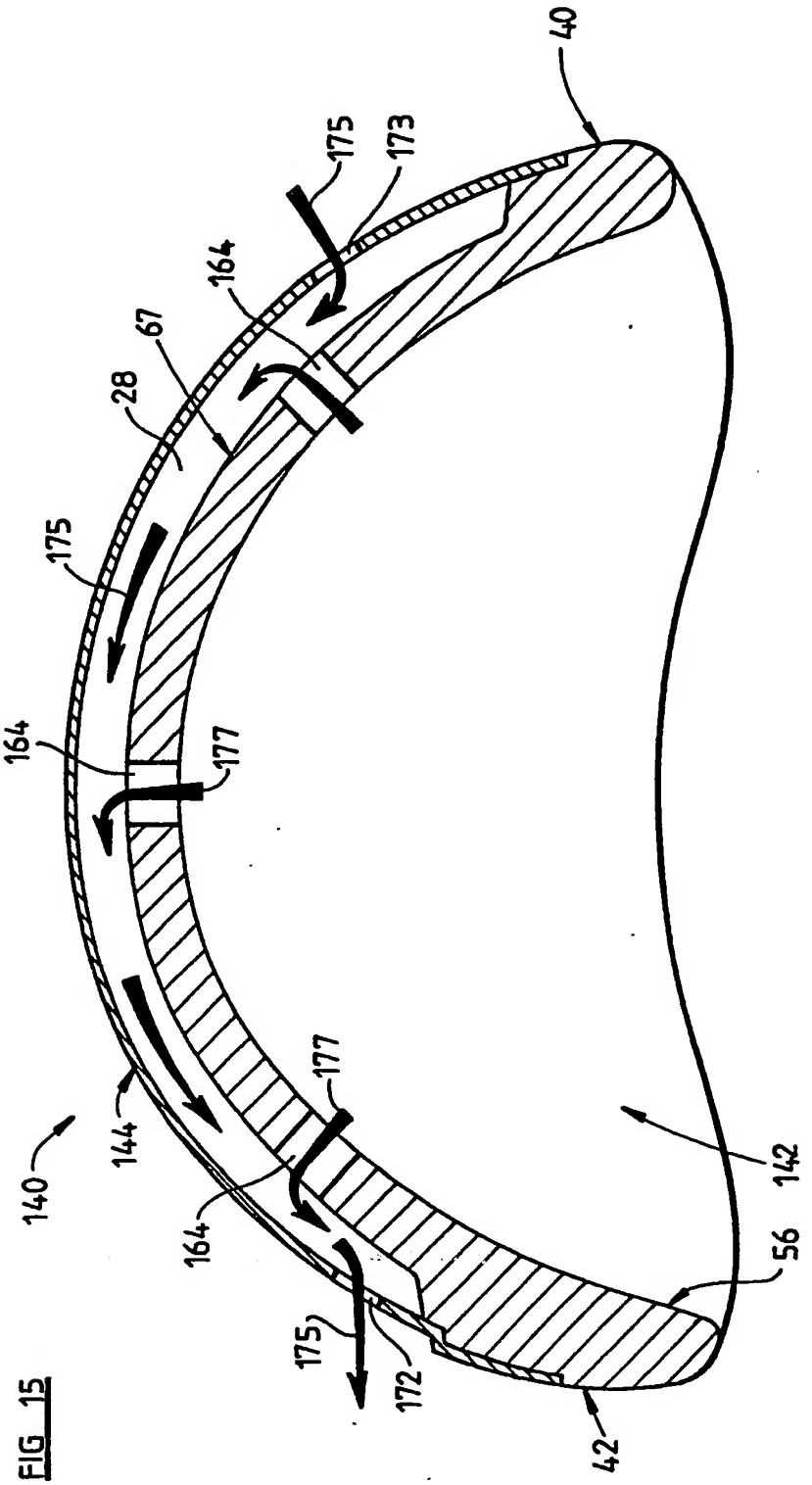

FIG 15

INTERNATIONAL SEARCH REPORT

International Appl tion No. PCT/AU 90/00494

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[5] A42B 3/12, 3/28

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC	A42B 3/00, 3/02, 3/06, 3/10, 3/12, 3/28

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched 8

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
X	AU,B, 77741/75 (491803) (MINE SAFETY APPLIANCES COMPANY) 5 August 1976) (05.08.76) see pages 3 to 5 and figures 1 to 8	(1,2,11,12,14,15, 16,17)
A	AU,A, 43776/79 (CANADIAN PATENTS AND DEVELOPMENT LIMITED) 30 January 1979 (30.01.79) see pages 1 and 2 and figure 1	
X	AU,A, 52081/86 (AIRSORB PTY, LTD) 19 June 1986 (19.06.86) see pages 4 to 8 and figures 1 and 3a	(1,2,11,12,13,14, 15,16,17,21)
X	WO,A, 81/03267 (BLOMGREN) 26 November 1981 (26.11.81) see pages 1 to 3 and figure 3	(18)
X	WO,A, 84/01697 (FIGGIE INTERNATIONAL INC.) 10 May 1984 (10.05.84) see especially figures 1 to 4 and pages 3 to 7	(1,2,11,12,14,15, 16,17)

(continued)

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11 December 1990 (11.12.90)	24 December 1990
International Searching Authority	Signature of Authorized Officer
Australian Patent Office	R.M. WEBER

Form PCT/ISA/210 (second sheet) (January 1985)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X	US,A, 4586200 (POON) 6 May 1986 (06.05.86) see figures 1 and 5 and pages 1 and 2	(1,2,11,12,14,15, 16,17)
A	DE,A, 3540883 (NAVA) 22 May 1986 (22.05.86) see pages 5 to 9 and figures 1 and 4 (& AU,B, 49984/85)	
X	EP,A, 217996 (AB AKTA BARNSAKERHET) 15 April 1987 (15.04.87) see pages 1 and 2 and figures 6 and 7	(1,2,11,12,13,14, 15,16,17,21)

V. [ ] OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 1

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.[ ] Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2.[ ] Claim numbers , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3.[ ] Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4 (a):

VI. [ ] OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 2

This International Searching Authority found multiple inventions in this international application as follows:

Claim 1 for example defines a liner formed with projections which engage with the inner surface of a shell of a helmet, however claim 18 defines an outer covering with a liner which has a groove and air passages hence claim 1 and 18 do not have a single common inventive concept. Note that the remainder of the independent claims tend to define a helmet or liner of a similar scope as claim 1.

1.[ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2.[ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3.[ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. [X] As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

[ ] The additional search fees were accompanied by applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 90/00494

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members					
AU 77741/75	CA	1015503	DE	2504849	GB	1494252
	IT	1037888	JP	50150537	US	3877076
	ZA	7500793				
AU 43776/79	CA	1101755	DE	2903305	FR	2416694
	GB	2014036	JP	55001381	US	4227520
	ZA	7900404				
AU 52081/86	CA	1258353	EP	241464	US	4724549
	WO	8603383				
WO 81/03267	BE	888896	DK	79/82	EP	51648
	FI	820141	NO	820166	US	4443891
WO 81/01697	EP	124586	IL	70028	US	4534068
DE 3540883	AU	49984/85	BR	8505849	FR	2573289
	GB	2167285	IT	1177288	JP	61179177
	LU	86170	NL	8503189	SE	8505503
	US	4704746	ZA	8507942		

END OF ANNEX